

May 2002

Advisory Circular (Working Draft – Not For Public Release)
AC No: 25-795(d)

Subject: Survivability of Systems

1. Purpose: This Advisory Circular provides a means, but not the only means, of compliance with § 25.795(d) , and discusses the rulemaking which implements ICAO Annex 8, Appendix 97 Standards, pertaining to an aircraft design requirement for Survivability of Systems for all new (passenger) aircraft with greater than 60 seats or a 100,000 Pounds MTOW.
2. Related FAR Sections: Title 14, Code of Federal Regulations (14 CFR) Parts 25 and 14 CFR §§ 25.365; 25.795; 25.1309
3. Discussion: The International Civil Aviation Organization adopted certain requirements related to security aspects of airplane design in amendment 97 to Annex 8. Included is a requirement that flight-critical systems should be designed and separated such that airplane survival is maximized for any event (e.g., damage due to an explosive device) that causes airplane system damage. For the purpose of addressing this requirement, any structural damage that might result from these events is not considered. This requirement only addresses damage to systems and their effect on safe flight and landing. Flight-critical systems shall be specified by the manufacturer. Section 25.795(d) does not introduce reliability requirements for systems and does not mandate redundancy for systems that are not required to be redundant.
4. Compliance: There are at least two approaches that will satisfy the systems survivability requirement. These are achieved through systems separation or systems protection. Systems separation is based on the idea that any critical system having a redundant or backup system can be separated sufficiently to ensure a high probability that both systems will not be damaged from any single event. Systems protection is attained by shielding critical systems against any harmful event. Designing for systems protection, instead of separation, should only be relied upon if separation is impractical.

Although airplane fuselage diameters vary widely, the percentage of space devoted to systems installations in general decreases with larger airplanes. This is partly because the size of systems are driven more by their function than by the size of the airplane. That is, space allocation for individual systems does not vary significantly with airplane size. This affords the opportunity of larger airplanes to separate systems to a greater extent than smaller ones. Even if systems were scaled with airplane size, the allowable separation distances would naturally increase with airplane size. The separation requirement provided below recognizes this physical relationship.

In order to provide a reasonable and practical method for establishing a minimum separation between redundant systems, the following formula, derived from § 25.365(e), is defined in the rule:

$$D = 2\sqrt{(PA_s / \pi)}$$

Where:

D = minimum separation distance between redundant systems, in feet.

$$P = \frac{A_s}{6240} + 0.024 \quad A_s = \text{maximum cross-sectional area of pressurized shell normal to the longitudinal axis, in square feet}$$

The separation distance, D , need not exceed 5.05 feet. This formula would be used anywhere within the pressurized fuselage. The requirement to maintain systems separation distances, based on this formula, is not intended to be applied to areas outside of the fuselage inner mold line (IML) e.g., wing root or empennage.

Certain areas within the fuselage may be excluded from strict application of the separation criteria but are nevertheless expected to achieve the best separation distances possible. Specific areas that meet this limited exclusion include:

- a. Fuel tanks - not considered to be a system that can be separated.
- b. Flight deck - aircraft geometry and convergence of systems in this area precludes full system separation.
- c. Areas where physical separation is impractical due to airplane geometry or other constraints (e.g., the aft fuselage area where the fuselage diameter tapers, preventing full separation).
- d. Electronic & Equipment Bays - concentration of numerous systems in a confined area prevents full separation. These areas should receive special consideration since they contain a large number of flight-critical systems. In this case, redundant systems should be separated within the compartment to maximize the potential for continued function after an event. This could be achieved, for example, by locating flight-critical systems in areas of the E&E bay furthest from the passenger or cargo compartments. Blast shielding is not a substitute for system separation but may be a useful approach for the E&E bay.

Figure 1 illustrates the regions that critical systems must be separated. Except for the items specifically excluded, if redundant systems separation is unattainable in a specific area, then one of the redundant systems and its vital components must be protected in that area. Protection should only be pursued if separation is not an available option. Acceptable systems shielding and/or inherent protection should be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second without disabling the system. The ballistic resistance of 0.09-inch thick 2024-T3 aluminum plate offers an equivalent level of protection. Credit may be taken for any permanent barriers between the system and a potential explosive device location that can be shown to offer fragment protection. In addition, the system design must incorporate

features that minimize the risk of its failure due to large displacement of the structure to which it is attached. This may include flexibility in both the system and/or its mountings. In the absence of test evidence, alleviating rationale or special circumstances, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere within the protected region. Frangible attachments or other features that would preclude system failure may also be incorporated.

The use of shielding should only be provided to protect the systems against ballistic threats and not against blast pressures. Several explosive tests conducted by the FAA have shown that systems are unaffected by blast pressures and efforts to defend the system against blast will likely increase damage rather than mitigate it. Therefore, ballistic shielding should be no larger than absolutely necessary to allow the blast pressures to pass without resistance.

Compliance shall be shown by design and analysis for each affected zone and flight-critical system.

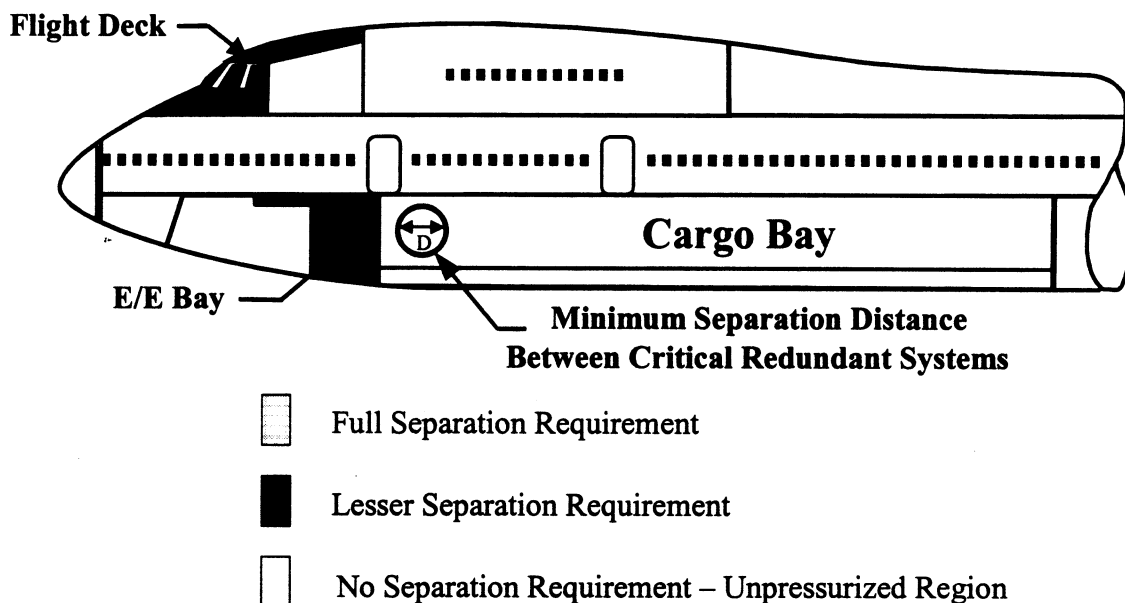


Figure 1. Regions Requiring Separation of Critical Redundant Systems

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| Subject: Least Risk Bomb Location (LRBL) | Date: DRAFT 5/15/02 | AC No: 25.795 (c) |
| | Initiated By: ANM-115 | Change: |

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1. **PURPOSE:** This Advisory Circular discusses the rulemaking action which implements ICAO Annex 8, Appendix 97 Standards, pertaining to an airplane design requirement for a Least Risk Bomb Location (LRBL) for all new passenger airplanes with greater than 60 seats or a 100,000 Pounds MTOW and the requirement that those LRBL procedures be made available to the flight crew during flight.
 - a. The means of compliance described in this document is intended to provide guidance to supplement the engineering and operational judgment that must form the basis of any compliance findings relative to the certification requirements.
 - b. Like all advisory circular material, this AC is not, in itself, mandatory, and does not constitute a regulation. It is issued to describe an acceptable means, but not the only means, for demonstrating compliance with the requirements for transport category airplanes. Terms such as 'shall' and 'must' are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used.

This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

2. **RELATED FAR SECTIONS:** Title 14, Code of Federal Regulations (14 CFR) Parts 25 and 121:

§ 14 CFR 25.795 Security Considerations
§ 14 CFR 25.1585 Operating Procedures
§ 25 CFR 121.135 Contents

3. **FORMS AND REPORTS:**

“FAA Recommended In-Flight-Emergency Safety Procedures for Suspect Device (“Bomb”) On Board (Least Risk Bomb Location {LRBL} Procedures)”, Sensitive Security Information (Limited Distribution)

- Available upon request to those with a certified “need to know” from:

TSA Explosives Unit, ACS-50
800 Independence Avenue, SW
Washington, DC 20591
FAX: 202-493-4263

Requests should be in writing on official letterhead stating a need for the information. Include an e-mail address for a prompt reply. These procedures are exempted from general public disclosure under 5 USC 552.

4. **DEFINITIONS:**

Least Risk Bomb Location (LRBL): The location on the airplane where a bomb or other explosive device should be placed to minimize the effects to the airplane in case of detonation.

5. **GENERAL GUIDANCE FOR ESTABLISHING AN LRBL**

- a. **Historical Practice.** The FAA recommended Least Risk Bomb Location procedures (LRBL), which have evolved since 1972 with voluntary participation by the airplane manufacturers, have been demonstrated to significantly reduce the effects of an explosion in the passenger cabins of large commercial airplanes using only readily available materials.

The ICAO Security Manual also provides guidance to operators on the procedures to invoke once a suspect item is found onboard an airplane. Information is also provided on the location of the LRBL.

- b. Purpose. The purpose of this guidance material is to establish those areas of concern that need to be addressed when finding compliance with the rule. These include the amplifying effects of the pressure differential between the cabin and the outside air. These can be significant and maximum damage is sustained when an explosion occurs in a fully pressurized airplane.

When a suspect item is encountered in the cabin of an airplane in-flight, measures to minimize its effect include a partial reduction in the cabin pressure, with full depressurization preferred, to reduce the damage caused by an explosion. Other possible countermeasures may include procedures to minimize the loss of the integrity of the structure or systems, the use of explosive containment devices, and operational procedures established in consideration of the airplane performance.

- c. Design Considerations. The previous voluntary approach to LRBL, that is, identification of the safest location after the basic design was completed, would not necessarily provide the enhancements to safety that would be possible if the LRBL were included in the initial design process. Therefore, additional features may need to be explored to improve safety. Design considerations may include specially sized areas or pressure relief panels in the cabin structure where a suspect device should be placed by crewmembers. On airplanes with more than one passenger deck, more than one LRBL may be desirable.

6. LRBL IDENTIFICATION AND DESIGN

- a. When determining the Least Risk Bomb Location (LRBL), the following operational and design issues should be addressed:
 - (1) If a site adjacent to the fuselage skin is chosen, a portion of the structure should be assumed to be lost. The structural capability of the airplane in the presence of the resulting opening should be determined. For example, if the LRBL is a door, the entire door should be assumed to be lost. An area that is not a door should consider the following:
 - i. The LRBL fuselage-skin blowout area must be discontinuous from the surrounding structure so cracks developed in the blowout section cannot propagate into the surrounding structure.
 - ii. The dimensions of the LRBL blowout region should be no smaller than a 30-inch diameter circle. However, those dimensions may be reduced to no less than a 20-inch diameter circle on airplanes with a maximum type certificated passenger capacity of less than 90, if standard arrangements and other considerations prevent a larger diameter.
 - iii. Adequate space must be available to place the attenuating materials required by the operational procedures.
 - iv. Assure that provisions allow for the placement of the suspect device as close

to the fuselage skin as possible. That is, interior features (galleys, closets, seats etc.) should not obstruct access to, or the space available for, the LRBL.

- (2) The location of the LRBL should be based on considerations of the secondary effects from structural losses to other parts of the airplane (e.g. ingestion of debris into engine, large mass strikes on tailplane, smoke, fire etc) or passenger hazard.
- (3) System integrity should be evaluated in the area likely to be affected around the LRBL. Wherever practicable, flight critical systems should be kept 18 inches away from the established LRBL contours, as shown in Figure 1. In addition, flight critical systems should also be kept out of the area under the floor at the LRBL, for a distance of 30 inches inboard, over the width of the LRBL cutout, also shown in Figure 1). This applies to systems that are attached to the floor beams, or mounted above the bottom of the floor beams. This guidance is separate from the requirement of 25.795(d).

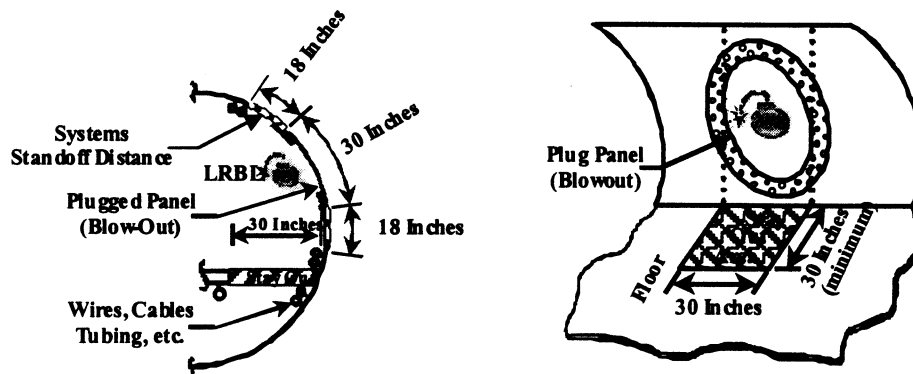


Figure 1. LRBL Design Dimensions

- (4) Where the criteria provided in paragraph 6.a.(3) would conflict with the requirements of 25.795(d), maximizing system separation takes precedence. However, in this case, consideration should be given to adding fragment and large structural deformation protection to systems that must be run in proximity to the LRBL.

Systems shielding and/ or inherent protection must be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second. The ballistic resistance of 0.09-inch thick 2024-T3 aluminum offers an equivalent level of protection. System designs must incorporate features that minimize the risk of their failure due to large displacements of the structure to which they are attached. This may include flexibility in both the systems and/or their mountings. In the absence of test evidence or alleviating rationale, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere within the protected region. Frangible attachments or other features that would preclude system failure may also be

incorporated.

- b. Traditionally, the LRBL has been chosen to be at a location where there is intrinsic structural reinforcement. However, other measures may be taken to meet the intent of the rule. An example would be a containment system. Such an approach would require concurrence of the Administrator to establish the appropriate criteria.
- c. In most circumstances, it is preferable to reduce the cabin pressure differential to zero. Reductions of fuselage pressure are known to be an extremely effective measure in ensuring structural integrity in the event of a detonation.
- d. The operational requirements of 121.135(b)(24) require that information on the LRBL be available to the flight crew during flight. The LRBL is required to be identified in the flight manual, and should be presented concisely and in a form that is easily understood.
- e. Destructive testing is not required.

Cargo Compartment Fire Suppression Advisory Circular

Final Revision – 25.795 (b)(3)

1. Purpose: This advisory circular provides a means, but not the only means of compliance with § 25.795 (b)(3) and discusses the rulemaking action that implements the intent of ICAO Annex 8, Amendment 97 Standards, pertaining to airplane cargo-compartment design requirements. An applicant may propose an alternate means of compliance to the Administrator. This rule requires that the cargo compartment fire suppression systems, including their suppressing agents, must be designed so as to take into consideration a sudden and extensive fire, such as could be caused by an explosive or incendiary device. Based on the assumptions given in paragraph 5 of this AC, the only components of the system requiring special attention are the storage/activation/distribution components that are not installed in an area considered remote to the cargo compartment, due to their vulnerability to fragments and/or large deformations of supporting structure resulting from an explosive event.
2. Related FAR Sections: § 25.851(b), 25.855, 25.857, 25.858
3. Background: Existing cargo-compartment fire-protection systems are capable of several functions. The initial function is to detect a fire within a cargo compartment. Once a fire is detected, the system provides a warning to the flight crew compartment. The flight crew then activates the fire suppression system to discharge suppression agent to subdue the fire in the affected cargo compartment.

Past regulations required that the cargo fire-protection systems be capable of suppressing any fire likely to occur in a cargo compartment. However, the regulations did not require the cargo fire-protection systems to be capable of withstanding the effects of an explosive or incendiary device. This additional requirement is now included in §25.795 (b)(3) and requires that the cargo fire-protection system design consider those effects. Notwithstanding the basic assumptions, the follow-on discharge must be equally protected. The intent of this requirement is to protect the airplane from a fire resulting from the event (as defined in paragraph 4.a).

4. Definitions: For the purposes of this AC, the following are applicable:
 - a) Event. The activation of an explosive or incendiary device.
 - b) Suppression Agent. The substance, usually fluid or gas, discharged into the cargo compartment to suppress a fire.
 - c) Knockdown Discharge. The initial sudden application of suppression agent into the cargo compartment with the intent of extinguishing a fire in a cargo compartment.
 - d) Follow-on Discharge. Subsequent application of suppression agent into the cargo compartment with the intent of preventing the fire from rekindling if not extinguished after the knockdown discharge application of suppression agent.

- e) Storage Vessel. Component containing the suppression agent.
- f) Remote Installation. Isolation of a component from exposure to fragments and large deformations resulting from an event in the cargo compartment.

5. Assumptions: The following assumptions are included:

- a) Explosive and incendiary devices produce similar consequences.
- b) Activation of explosive and incendiary devices produce only surface fires. Based on several explosive tests conducted in luggage compartments by the FAA, deep-seated fires are extremely rare in explosive events.
- c) Existing cargo compartment liner requirements are assumed to be adequate. The reasons for this are:
 - 1) In the case of an event, the resultant fire is assumed to be a surface fire and the knockdown discharge system will extinguish such a fire even if the liner is breached.
 - 2) Cargo compartment liners are flame-penetration resistant per § 25.855(c).
- d) The cargo compartment fire detection system does not require explosive protection. The reasons for this are:
 - 1) If the event is small, there will be no effect on the fire detection system;
 - 2) If the event is large enough to affect the integrity of the fire detection system, the passengers or crew will notice the event. Then, if smoke or odors are present, the crew will know to discharge suppression agent to the affected area. In addition, the failure of the affected fire detection system must be annunciated to the crew for the specific compartment. As a result, no changes are required to make the fire detection systems resistant to one of these events.
- e) No additional suppression agent is required. Existing suppression agent requirements are sufficient per paragraph 5.c.1.
- f) Acceptable suppression agent. The ICAO standard recognizes that Halon suppression agents satisfy the intent of this requirement from the standpoint of suppression. However, Halon production has been banned because of environmental concerns as a chemical that contributes to depletion of the ozone layer. Although there are stores of Halon and its supply is not immediately a concern, Halon will not be available indefinitely. The FAA has been working with the International Halon Replacement Working Group (now the International Aircraft Systems Fire Protection Working Group) to establish minimum performance standards for new suppression agents that will provide capability "equivalent" to the existing Halon agents. These minimum performance standards will be published and adopted by the FAA as guidance for future agent approvals. Therefore, it is expected that this requirement will have no effect on the type of agents that will be used in the future.
- g) The pressure hull is not breached. This advisory circular assumes that the airplane pressure shell remains intact during one of these events even though some structural components within the airplane may fail or be damaged.
- h) Most components of the suppression system do not require protection against a pressure wave resulting from an event. The pressure wave from an event is assumed to act uniformly around the components, as observed from several experimental trials, and would not normally cause pressure damage to these components. However, any component that projects a surface area greater than four square feet (any single dimension greater than four

feet may be assumed to be only four feet in length) will require structural reinforcement to counter the inability of the pressure wave to uniformly propagate around large objects.

- i) The mechanisms that produce threatening damage are from large-scale deformations and fragmentation. An event can induce sizeable loads on large surfaces, causing components of the suppression system attached to these surfaces to deflect beyond safe limits and high-energy fragments can puncture distribution lines and storage devices.

6. Discussion: Cargo-compartment fire-protection systems generally contain a fire detection and fire suppression system. The normal system operation entails the fire detection system activating an alarm in the flight-crew compartment when fire is detected in a cargo compartment. The flight crew then activates the suppression system to discharge the suppression agent into the applicable cargo compartment.

The fire-detection system generally consists of fire detectors that sample air from a cargo compartment. When sufficient quantities of combustion byproducts enter a fire detector, the detector activates an alarm.

The cargo fire suppression systems generally consist of storage devices containing suppression agent, distribution tubing or piping, and associated hardware. When the suppression system is activated, an initial knockdown discharge of suppression agent is distributed to the cargo compartment. After the initial knockdown discharge, follow-on suppression agent is then distributed to the compartment either at a metered rate or as a discrete discharge.

When taking into consideration the effects of an explosive device on the cargo fire protection system, the assumptions in section 5 of this AC must be considered. As a result, the only part of the cargo fire protection system deemed necessary to be modified is the storage/activation/distribution system. Therefore, the proposed compliance methods will only address the storage/activation/distribution system and the types of damage that must be addressed are from fragmentation and large deformation of supporting structure.

Due to the damage that may result from an event, quantities of suppression agent, which may be considered toxic, may enter into compartments occupied by crew or passengers. However, the agent is considered to present less potential hazard than products of the fire itself.

7. Compliance: Compliance may be demonstrated by analysis and/or design review. An assessment of vulnerability for the storage/activation/distribution systems must be made.
 - a) Storage Devices and Activation. Storage devices and any electrical or mechanical devices that are attached to the storage devices for activation purposes would require protection. A general assessment of component vulnerability should include consideration of their location relative to a potential event, the arrangement of any feature (e.g., cargo compartment liner) between them and the event and their potential displacement from the features own displacement or deformation. There are at least three separate approaches that will satisfy compliance for the storage devices and their associated activation system.

- 1) Component Protection. Protect those components that are not installed in an area remote to a cargo compartment. Storage/activation devices or protective barriers that will withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second are acceptable. The ballistic resistance of 0.09-inch thick 2024-T3 aluminum offers an equivalent level of protection. Barriers with dimensions beyond those described in paragraph 5.h and their supporting structures designed to protect components must be able to tolerate a 15-psi static pressure load without deformation that would compromise the function of the system.
- 2) Remote installation. Install storage devices and/or their associated activation devices in an area that is remote from the cargo compartment. Items that are remote from the cargo compartment are considered acceptable without protection. Credit may be taken for any permanent barriers between the cargo compartment and the component that can be shown to offer fragment and or large deformation protection, as applicable. Barriers with dimensions beyond those of paragraph 5.h, and their supporting structures designed to isolate components and meet the remote criteria must be able to tolerate a 15-psi static pressure load in combination with any other loads applicable with their design without deformation that would compromise the function of the system. The fragment penetration requirements must also be met.
- 3) Provide redundancy. Redundant storage devices and their associated activation system components that are separated in accordance with §25.795(d) would be sufficient.
- b) Distribution System. Any of the following approaches separately or in combination are acceptable methods of compliance:
 - 1) Utilize redundant tubing. Redundant tubing systems that are separated in accordance with §25.795(d) would be sufficient. No additional measures would be necessary.
 - 2) Utilize tubing protection:
 - (i) Shielding. Shielding and or inherent protection of the tubing must be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second, and;
 - (ii) Tubing and Tubing Supports. The tubing system design must incorporate features that minimize the risk of tubing rupture or failure due to displacement of the structure to which it is attached. This may include flexibility in both the tubing and/or its mountings. In the absence of test evidence or alleviating rationale, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere along the tubing due to support structure (e.g., floor beam or other equivalent structure) displacements or adjacent materials, such as cargo liners or cargo substances, displacing against the tubing from the event in the cargo compartment. Frangible attachments or other features that would preclude tube rupture or failure may also be incorporated.

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| Subject: Protection of flight crew compartment (Smoke and fumes) | Date: DRAFT Initiated By: ANM-115 | AC No: 25.795 (b) (1) Change: |
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1. PURPOSE:

This Advisory Circular provides a means, but not the only means, of demonstrating compliance with § 25.795(b)(1) and discusses the rulemaking action which implements ICAO Annex 8, Appendix 97 Standards, pertaining to an aircraft design requirement that there be means to minimize entry into the flight crew compartment of smoke, fumes and noxious vapors generated by a fire from an explosion, which occurs outside of the flight deck in the airplane.

The means of compliance described in this document is intended to provide guidance to supplement the engineering and operational judgment that must form the basis of any compliance findings relative to the certification requirements.

The guidance provided in this document is intended for airplane manufacturers, foreign regulatory authorities, and Federal Aviation Administration transport-airplane type-certification engineers and their designees.

As with all advisory circular materials, this AC is not, in itself, mandatory, and does not constitute a regulation. It is issued to describe an acceptable means, but not the only means, for demonstrating compliance with the requirements for transport category airplanes. Terms such as 'shall' and 'must' are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used.

This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

2. RELATED FAR SECTIONS:

Title 14, Code of Federal Regulations (14 CFR) Parts 25:

§ 14 CFR 25.795

§ 14 CFR 25.831

§ 14 CFR 25.855

§ 14 CFR 25.857

3. BACKGROUND:

Prior to the adoption of Amendment 25-XX, the regulations did not specifically address the penetration of smoke into the flight deck except from a cargo compartment fire as required by 25.855(h)(2) and 25.857(c)(3). The regulation FAR 25.831(d) deals with smoke clearance from the flight deck. Specific guidelines are given in AC 25-9A for smoke penetration, smoke detection and smoke clearance. It describes the method of testing, including equipment requirements, test procedures and pass/fail criteria. This AC does not change any of those guidelines.

Current test procedures in AC25-9A do not allow for any smoke penetration into the flight deck from a cargo compartment. This AC recognizes and permits that some smoke may initially permeate the flight deck after an explosion or fire occurs anywhere else on the airplane. This is consistent with smoke test procedures used in the E/E bay.

4. DISCUSSION:

It is intended that the flight deck be protected from excessive penetration of smoke, fumes, and noxious vapors generated by explosions or fires anywhere on the airplane other than the flight deck.

As noted above, the current test procedures in AC25-9A do not allow any smoke penetration into the cabin and flight deck emanating from a fire in the baggage compartment. Section 25.795(b)(1) assumes that smoke, fumes, and noxious vapors resulting from the detonation of an explosive device may initially enter the flight deck until procedures are initiated to prevent smoke entry.

Flight deck ventilation systems are designed to supply relatively large quantities of air to meet the ventilation and temperature requirements. It has been shown in airplanes {Technical Note DOT/FAA XXX} that sufficient airflow rates can prevent smoke and gases

from entering the flight deck by creating a small differential air pressure between the flight deck and the cabin and/or adjacent compartments. With the flight deck door closed, a pressure boundary can be developed, driving air from the flight deck into the compartments adjacent to the flight deck through the gaps and openings with a velocity related to the gap size and pressure differential. The minimum pressure differential needed to prevent smoke entry has been found to be too small to accurately measure directly with instrumentation. However, covering the flight deck door opening with a thin sheet of plastic provides a flexible barrier that will noticeably deform when a light pressure differential exists. Anytime the plastic deflected towards the passenger cabin, smoke was prevented from entering the flight deck. This provides a visual method that can be used to demonstrate compliance. A good design practice would include minimizing possible routes of smoke entry (e.g. electronic equipment cooling systems, doors and floor gaps, clearances between the bulkhead and supporting structure, etc.).

5. SPECIAL CONSIDERATIONS:

The following special considerations shall be observed:

- a. The flight deck door is assumed to be closed. The flight crew would be expected to assure that the flight deck door is closed to block smoke entry.
- b. *No structural or systems damage need be considered.* The airplane structure and the systems are assumed to be functional for the purpose of demonstrating compliance. No reduction in performance is assumed in systems operations or airplane capabilities.
- c. *The airplane must be assumed to be operating under any phase of flight.* The applicant shall provide protection from excessive smoke penetration into the flight deck, regardless of the location and origin of the fire and during any flight phase, except as follows. This does not apply to short duration air conditioning “packs off” operations during take-off and initial climb, “packs off” operations during a “go-around”, landing procedures requiring a “hold” in the descent phase, or during idle descent operations. The ventilation system settings and distribution configuration should also be considered so that the design goal of providing protection from excessive smoke, fumes and noxious vapor penetrations into the flight deck is not compromised by other settings/procedures.
- d. *The flow behavior of smoke, fumes and noxious vapors is assumed to be identical to visible smoke.* The detection and removal of smoke is assumed to equally remove any fumes and noxious vapors that are present.
- e. *Fresh air must be used to achieve the required airflow to the flight deck in the presence of smoke.*

6. COMPLIANCE:

A positive pressure differential between the flight deck and any adjacent compartments,

taking into consideration temperature, buoyancy, and altitude effects, must be attainable in all certificated configurations.

Compliance may be shown by analysis and/or flight testing.

- a. Analysis – Analysis may be used to verify that a positive pressure differential between the flight deck and any adjacent compartment is met for the required airplane flight conditions. The applicant needs to be able to verify that the analysis accurately represents actual flight conditions.
- b. Test Demonstration - A 0.005-inch thick, or thinner, sheet of polyethylene may be attached to the top, sides and bottom of the door opening with the flight deck door fully opened or removed. The plastic should be sealed so that no air gaps exist around the entire perimeter of the door opening. Sufficient polyethylene should be used so that it can deflect at least 6 inches when light pressure is applied. With the airflow settings properly selected, the polyethylene sheet must deflect away from the flight deck. The center of the sheet will then be forced toward the flight deck past its neutral position and then released. If the sheet again deflects away from the flight deck past its neutral position within 10 seconds, a sufficient pressure differential has been demonstrated to meet this requirement. All flight conditions, except as noted in paragraph 5(c), must be demonstrated.
- c. Smoke tests may also be conducted using the guidance provided in AC 25-9A Prior to generating any smoke, select the airflow settings designed to protect the flight deck from excessive penetration of smoke, fumes and noxious vapors. Wisps of smoke that enter and immediately exit at the occupied compartment boundaries are acceptable as long as a light haze or stratified haze does not form.